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Chapter 4.0

Fine Mass Concentrations



This section presents an analysis of the CASTNet visibility-related air quality measurements, i.e., fine mass and its chemical constituents. Measurements taken in 1998 are emphasized, although data from 1994 through 1998 are presented and discussed. Annual concentrations of fine mass and their chemical constituents are shown. Quarterly variability is also discussed. Annual, quarterly, and peak 24-hour concentrations for the 5-year period are presented. Relationships between fine mass measurements and SO_4^{2-} concentrations are also presented.

Figure 4-1 presents 1998 annual and quarterly averages of fine mass measured at the eight visibility sites. Peak 24-hour concentrations measured during each quarter and for the year are plotted adjacent to the annual/seasonal averages. During 1998, the highest seasonal and 24-hour averages were observed during the third quarter. Annual values at all eight sites are below $15 \mu\text{g}/\text{m}^3$ and 24-hour values are below $60 \mu\text{g}/\text{m}^3$.

Figure 4-2 presents a map of annual averages of reconstructed fine mass. The data are provided in the form of a pie chart for each of the eight sites. The numerical value outside the pie is the measured fine mass concentration. The fine mass was reconstructed using the parameters recommended by Sisler *et al.*, 1996. Sulfate is the major contributor to fine mass at the eight CASTNet sites. Organic carbon and NO_3 are also important constituents, in approximately similar proportions. Figures 4-3 through 4-6 are maps of pie charts of 1998 quarterly reconstructed fine mass. Again, the highest quarterly averages were measured during the third quarter. SO_4^{2-} concentrations also peaked in the third quarter. Organic carbon is a large constituent in the warmer seasons and regions of the country, and NO_3 is relatively more important in the colder climates. The latter is consistent with the high NO_3 measured in the dry deposition network.

Figures 4-7 through 4-14 present time series of quarterly values of reconstructed fine mass and their major constituents from 1994 through 1998. The first and second quarters of 1996 are excluded because of the temporary shut-down of the network during the first half of 1996. The figures are sequenced by site beginning in the northeast and moving to the southwest, i.e., from CTH510 to SIK570. The legend on the figures explains the different shadings. The fine mass is given by the diamonds. The time series for the eight sites are fairly similar with peak fine mass values in the third quarter and minimum values in the first quarter. The evolution of the fine mass follows the annual cycle of SO_4^{2-} , which peaks in the summer months.

Bar charts that illustrate annual average and peak 24-hour concentrations of fine mass and their constituents are shown in Figures 4-15 through 4-22. Annual mean values are not presented for 1996 because of the network shut-down. Sulfate contributes approximately half the mass at the three westernmost sites and a larger fraction at the other five sites. The highest 24-hour concentrations range from about 25 up to 69 $\mu\text{g}/\text{m}^3$. The chemical composition of the fine mass during the days with high 24-hour values is generally dominated by SO_4^{2-} , although on a few days NO_3 , organic carbon, or soil dust is an important contributor.

Scattergrams of 24-hour fine mass and SO_4^{2-} concentrations measured at all eight visibility sites together are given in Figure 4-23 for the four quarters of 1998. The four scattergrams show reasonable correlations, indicating a relationship between fine mass and SO_4^{2-} throughout the year. However, the correlation coefficient is highest for the third quarter. These scatterplots and the previous analyses demonstrate clearly that SO_4^{2-} is a major contributor to atmospheric fine mass loading.

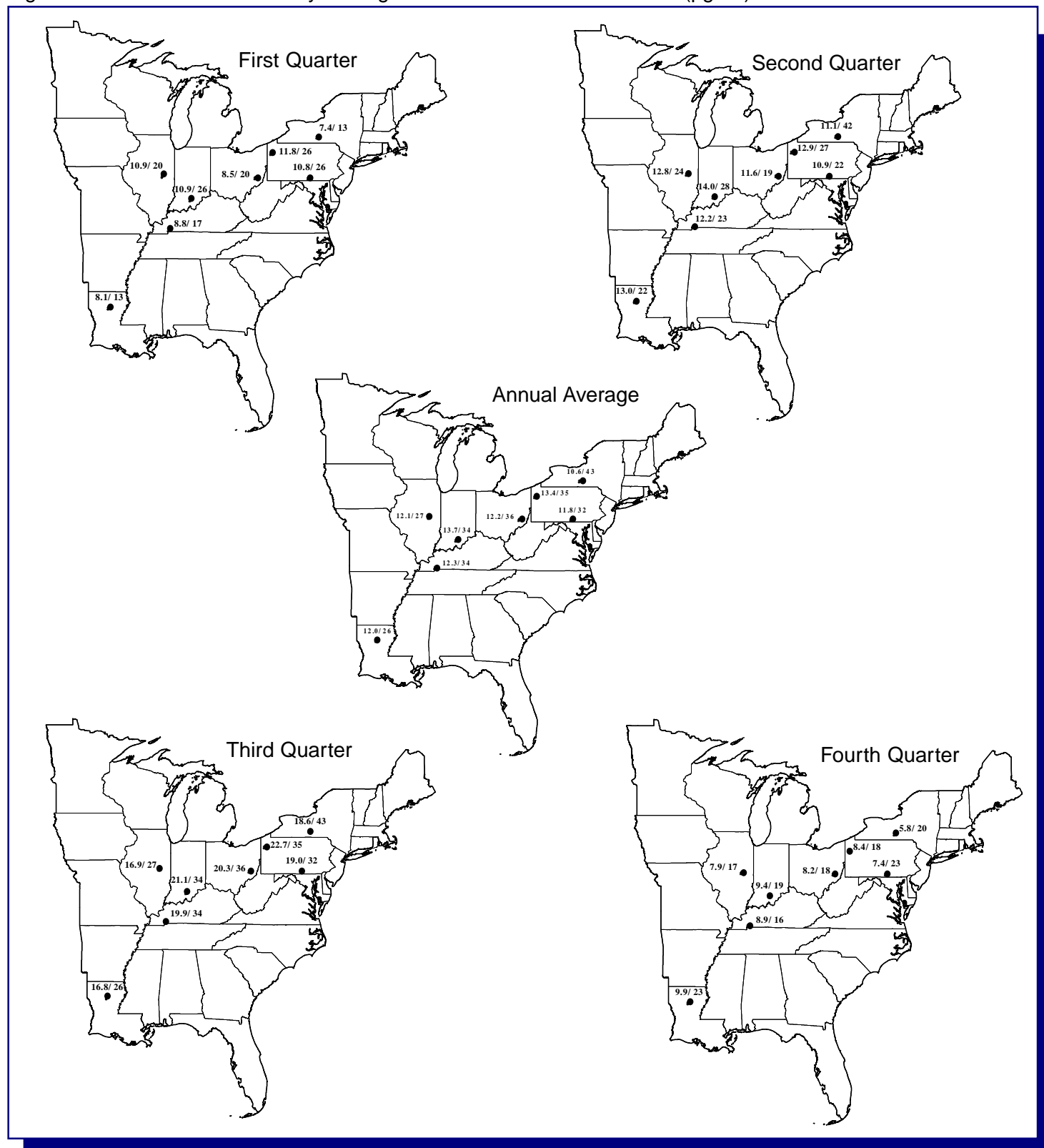
Figure 4-1. Annual and Quarterly Average/Peak 24-hour Concentrations ($\mu\text{g}/\text{m}^3$) of Fine Particle Mass for 1998

Figure 4-2. 1998 Annual Reconstructed Mass

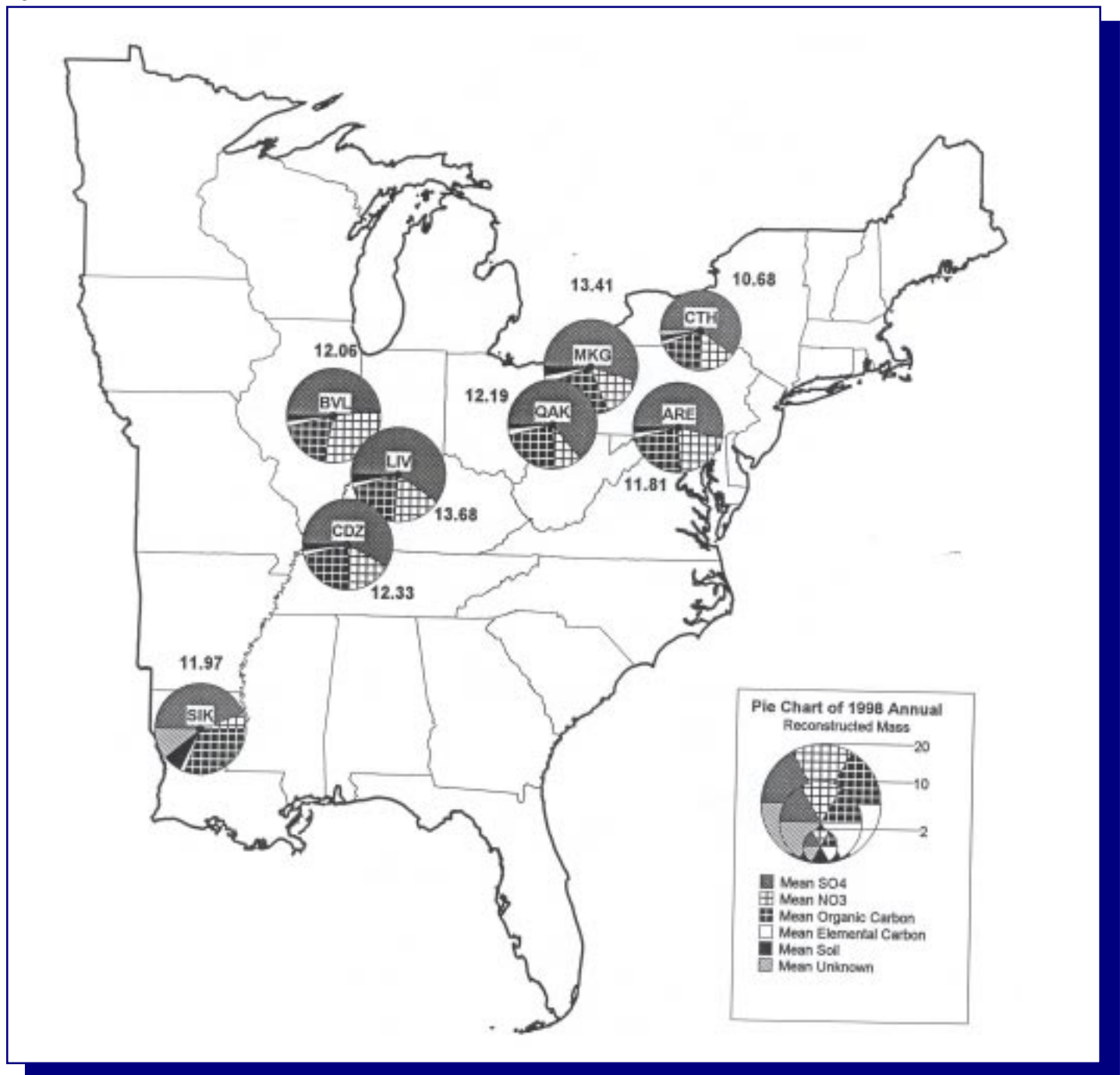


Figure 4-3. First Quarter 1998 Reconstructed Mass

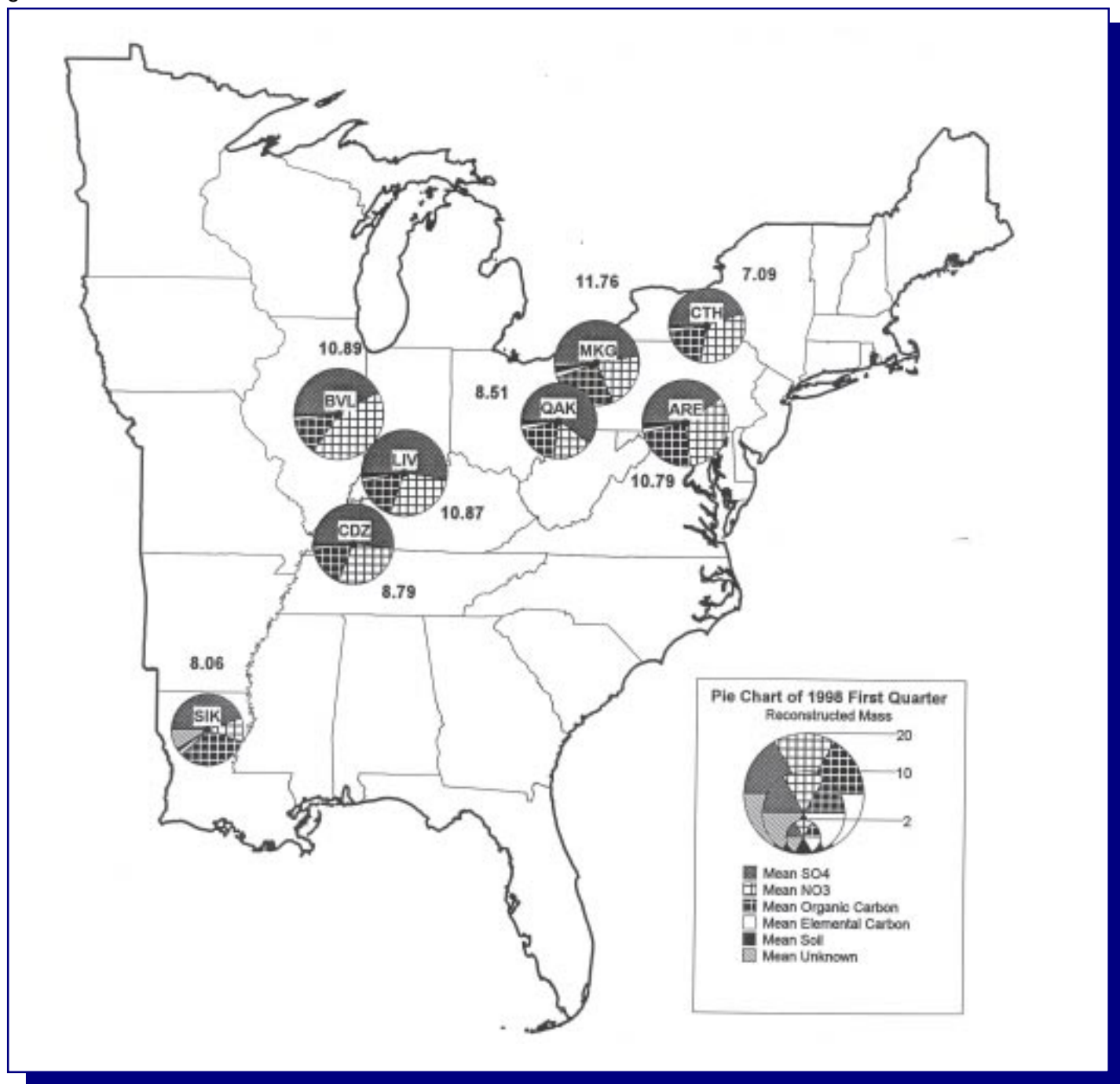


Figure 4-4. Second Quarter 1998 Reconstructed Mass

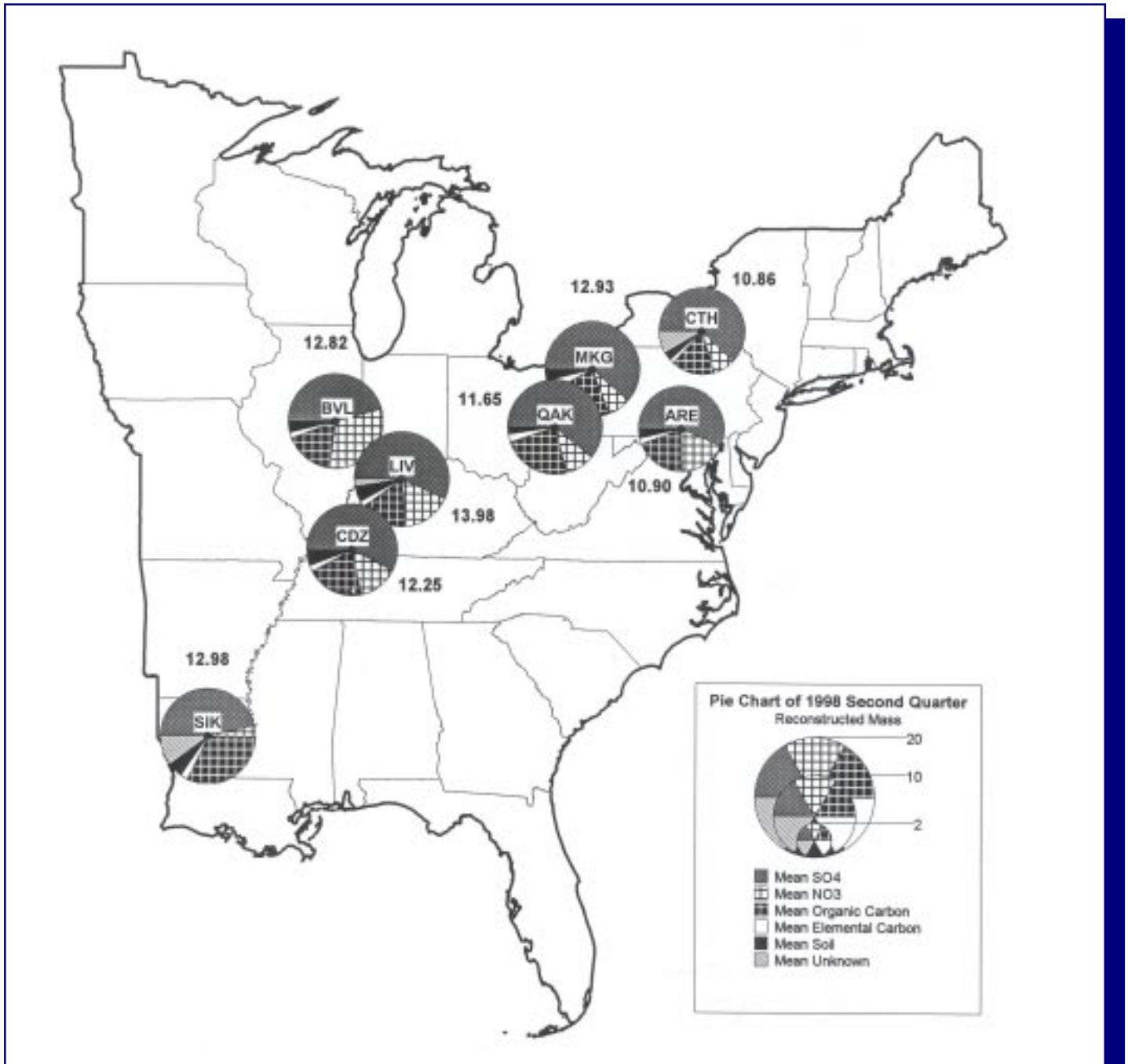


Figure 4-5. Third Quarter 1998 Reconstructed Mass

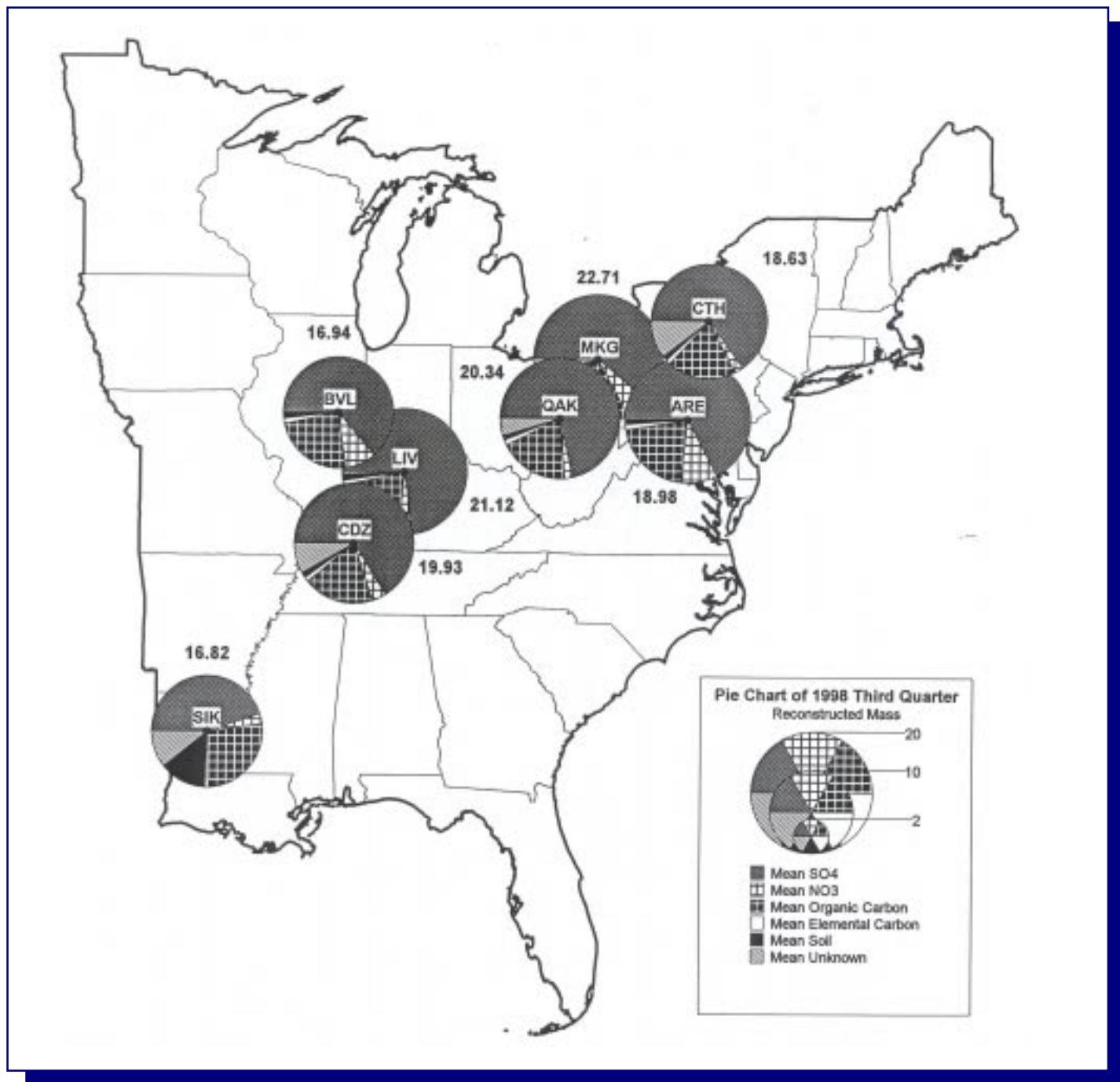


Figure 4-6. Fourth Quarter 1998 Reconstructed Mass

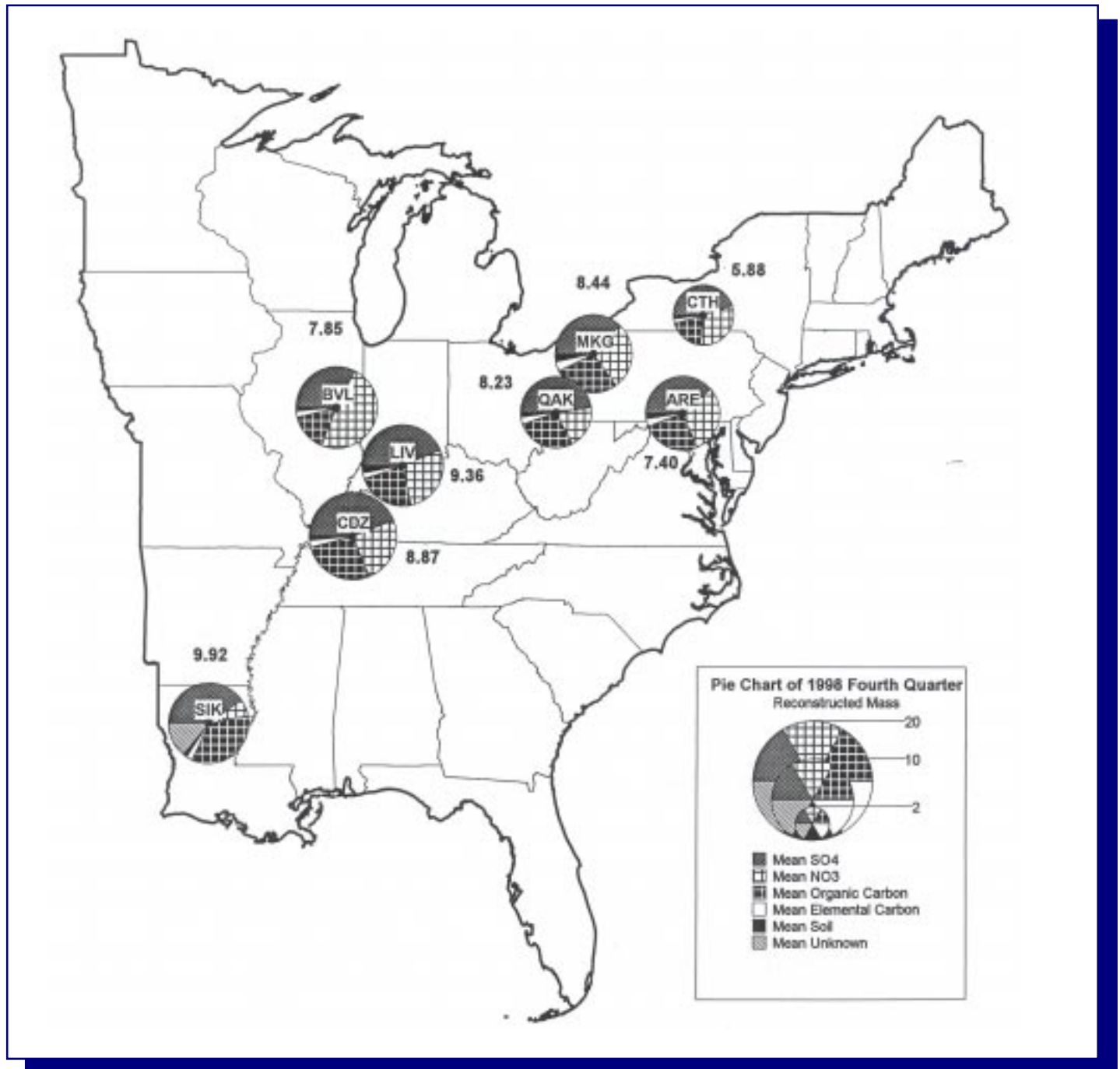


Figure 4-7. Times Series of Quarterly Reconstructed Fine Mass at Site CTH510

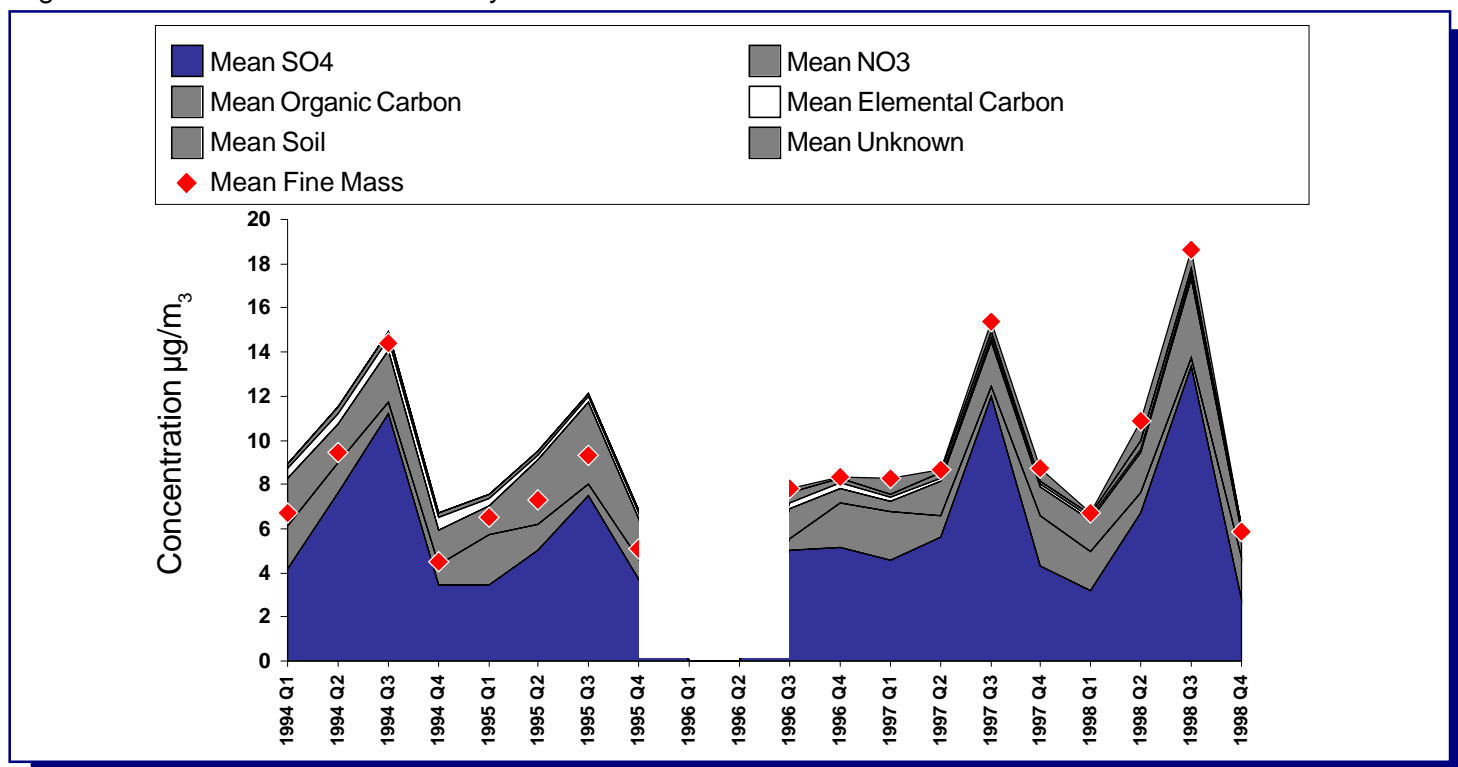


Figure 4-8. Times Series of Quarterly Reconstructed Fine Mass at Site ARE528

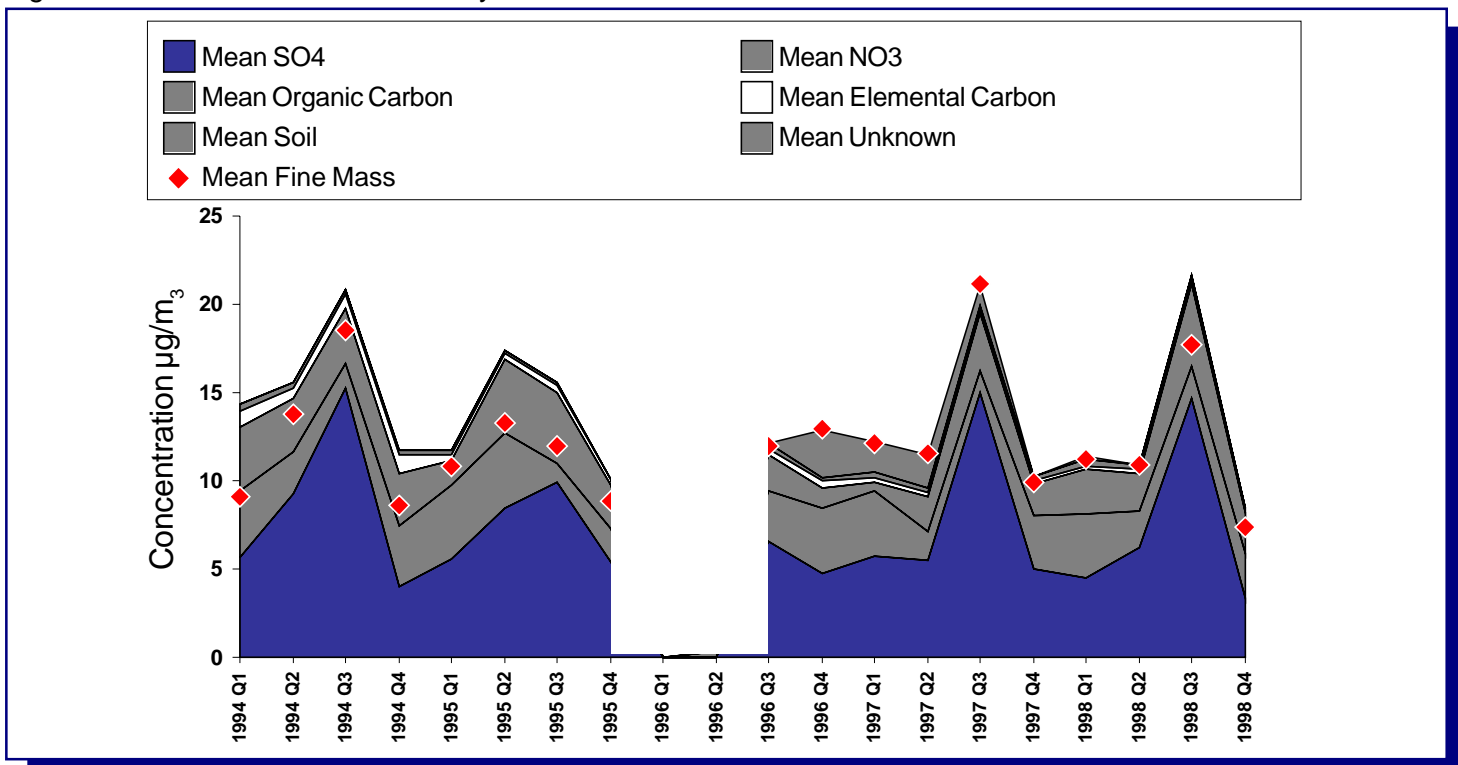


Figure 4-9. Times Series of Quarterly Reconstructed Fine Mass at Site MKG513

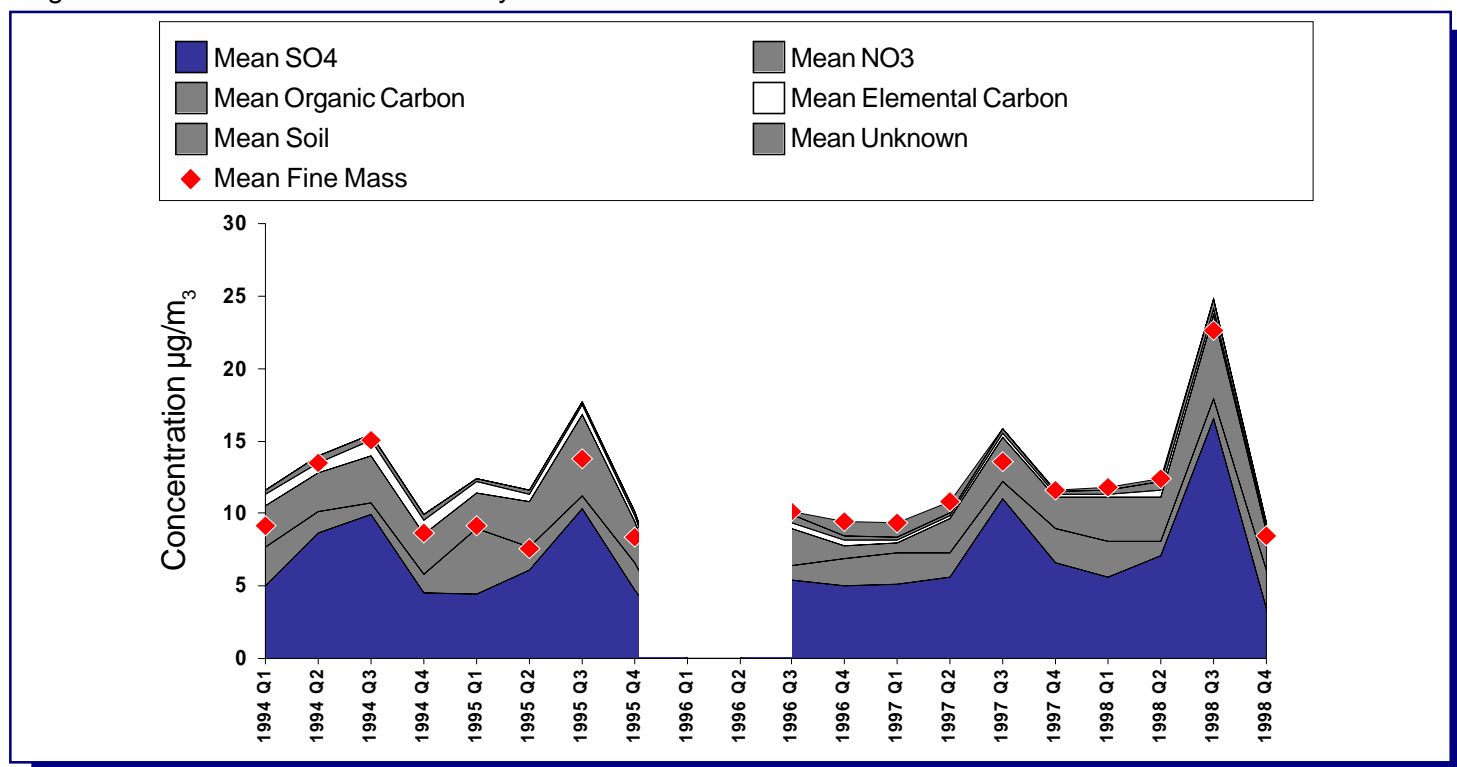


Figure 4-10. Times Series of Quarterly Reconstructed Fine Mass at Site QAK572

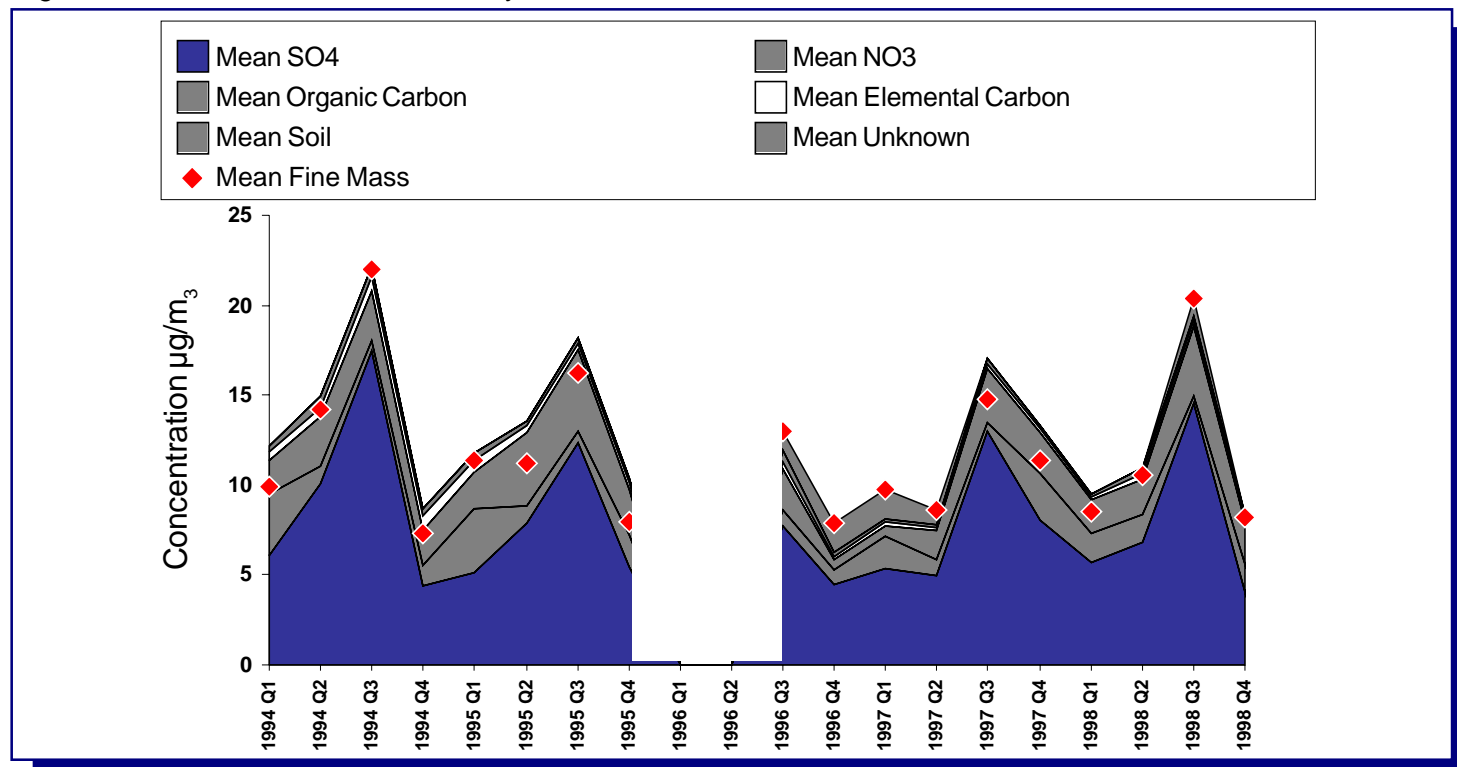


Figure 4-11. Times Series of Quarterly Reconstructed Fine Mass at Site LIV573

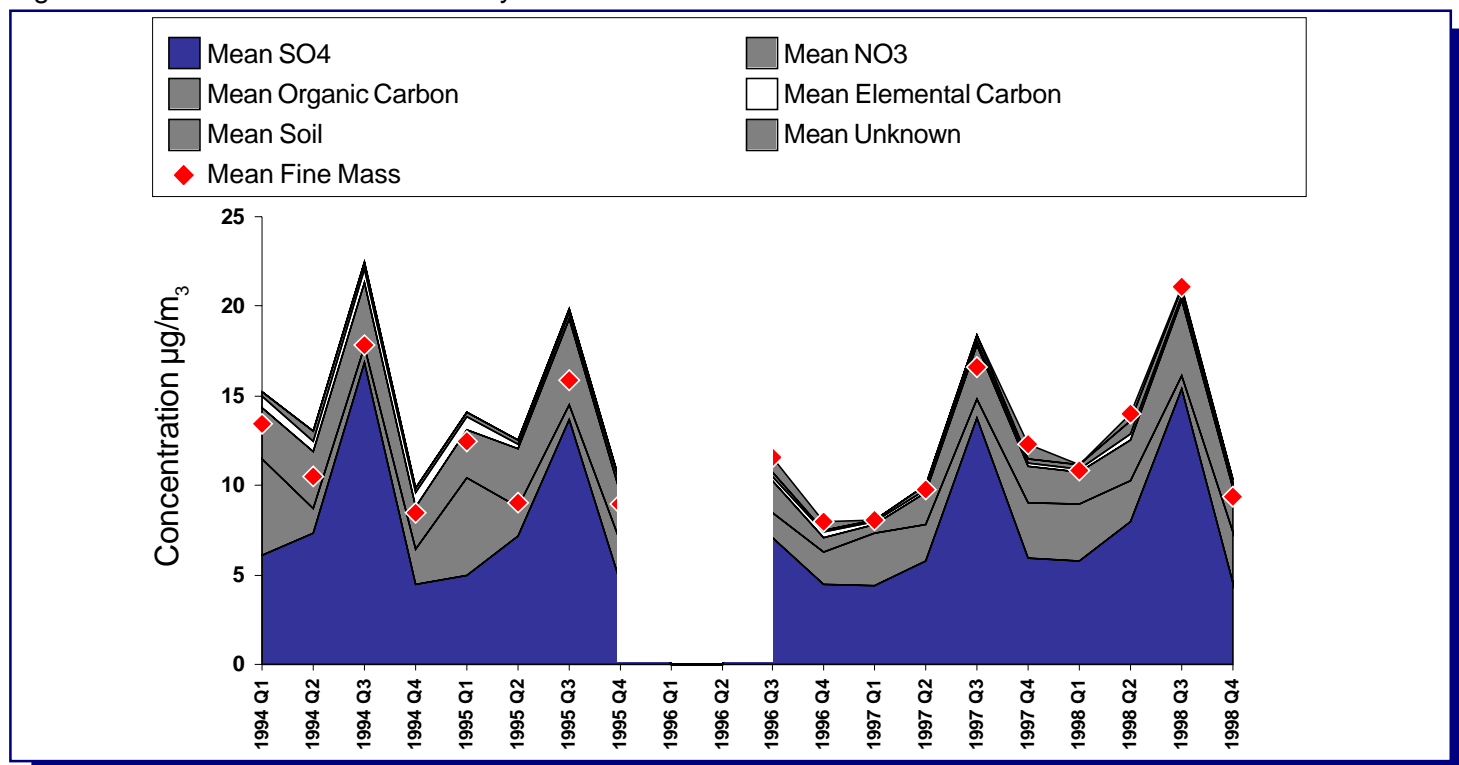


Figure 4-12. Times Series of Quarterly Reconstructed Fine Mass at Site BVL530

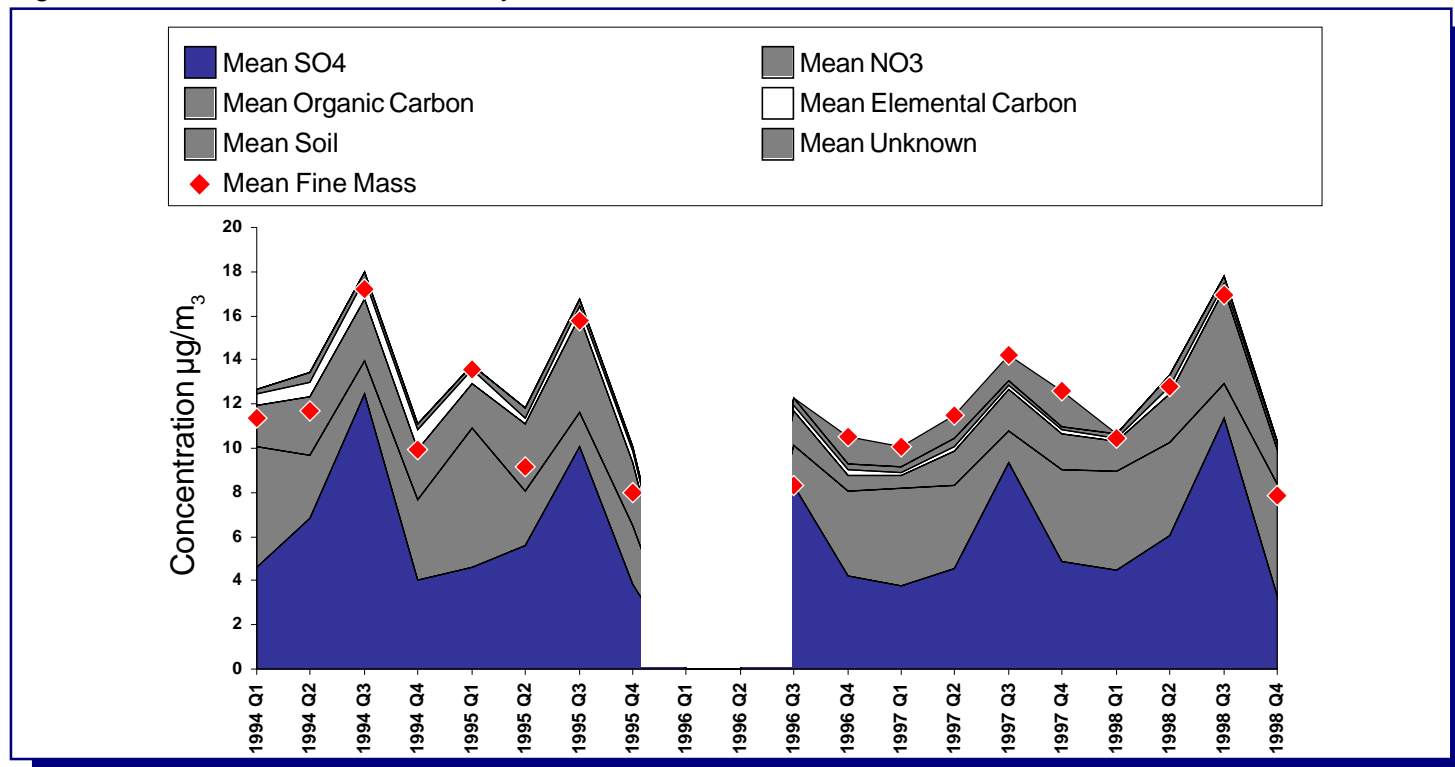


Figure 4-13. Times Series of Quarterly Reconstructed Fine Mass at Site CDZ571

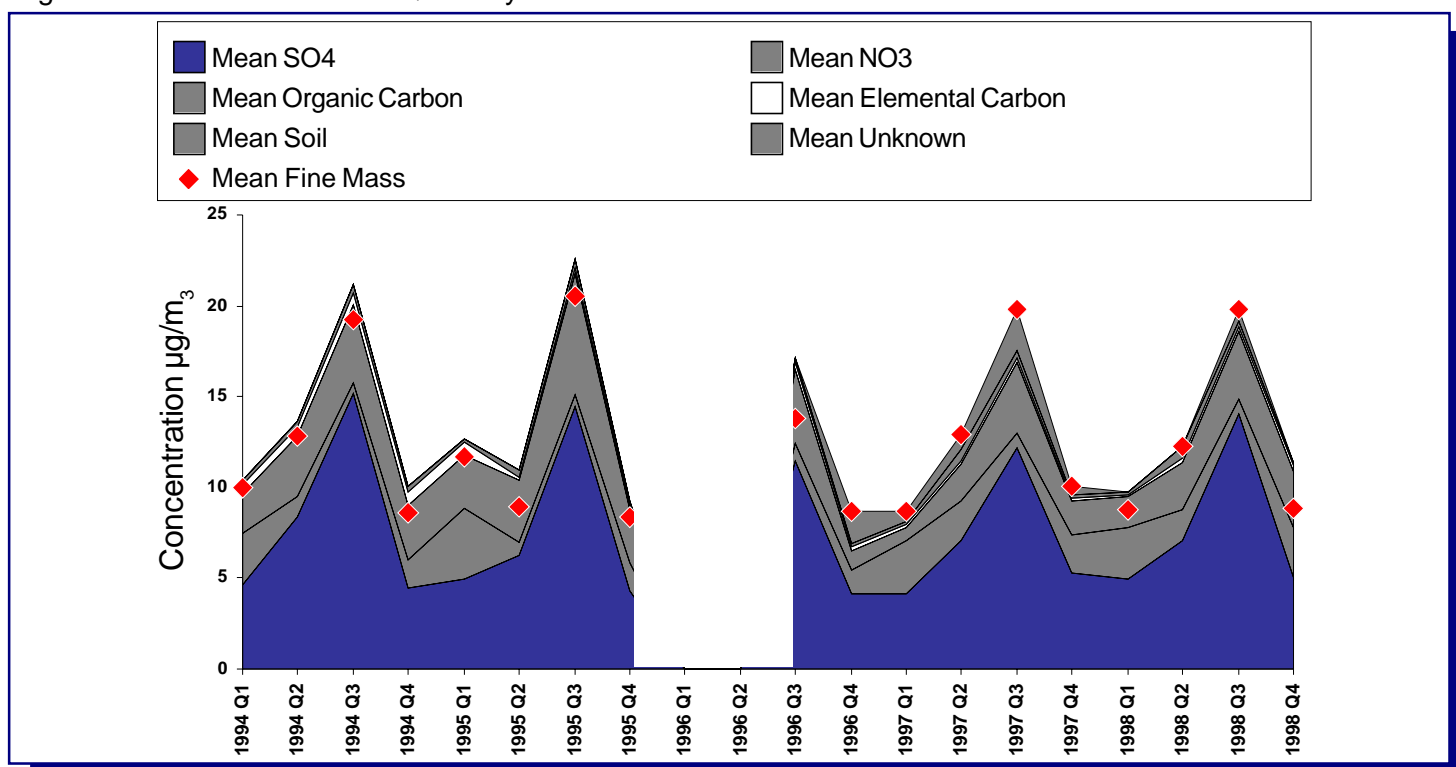


Figure 4-14. Times Series of Quarterly Reconstructed Fine Mass at Site SIK570

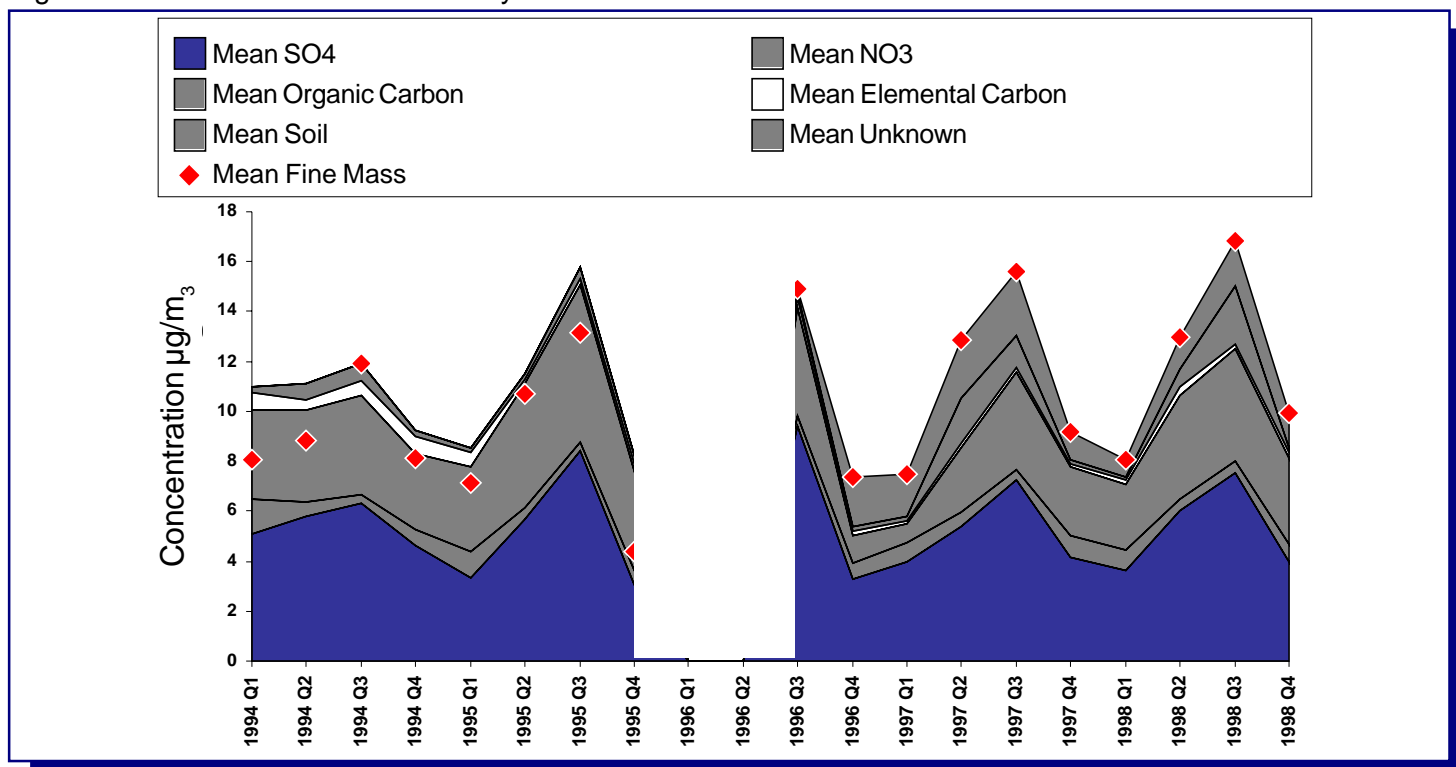


Figure 4-15. Annual and Peak 24-hour Fine Mass Concentrations and Chemical Constituents for Site CTH510

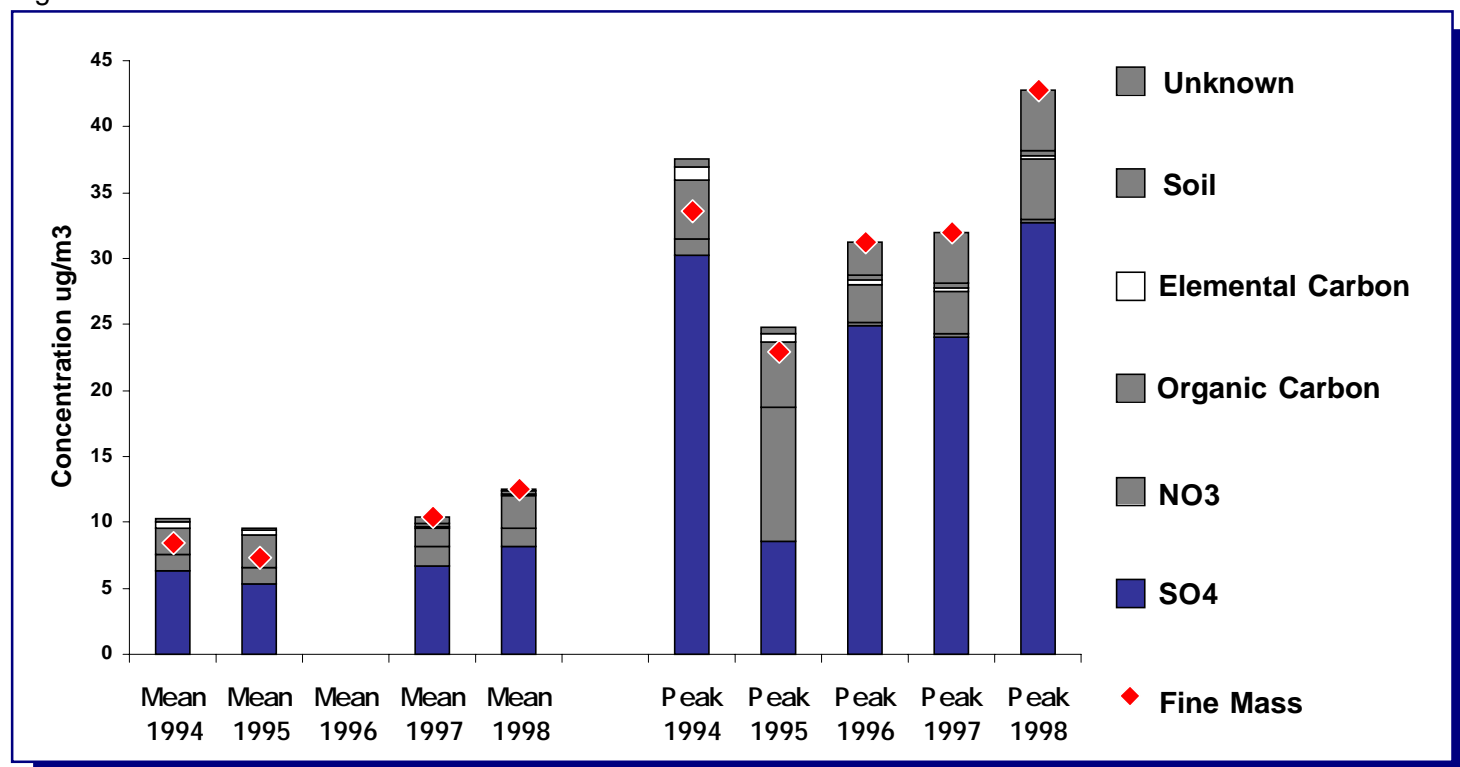


Figure 4-16. Annual and Peak 24-hour Fine Mass Concentrations and Chemical Constituents for Site ARE528

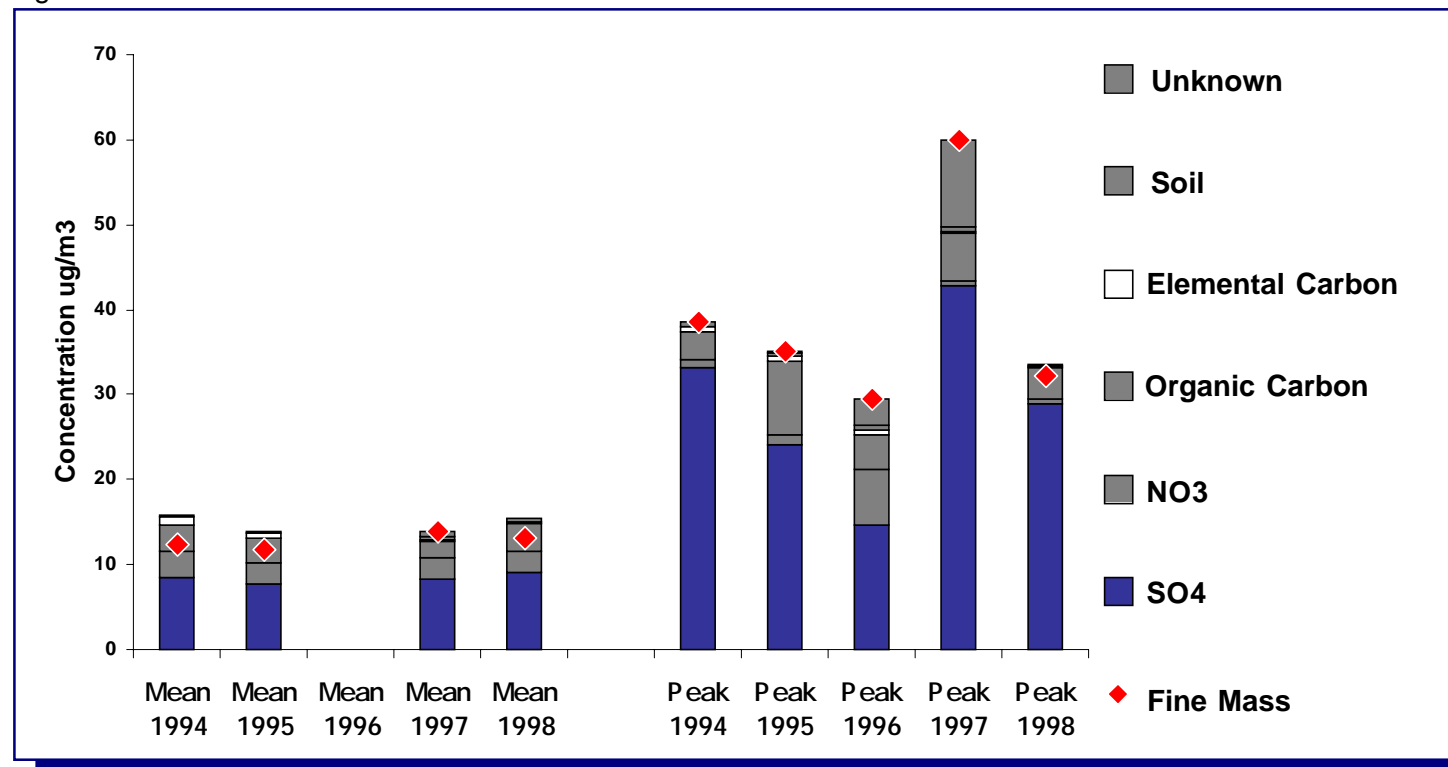


Figure 4-17. Annual and Peak 24-hour Fine Mass Concentrations and Chemical Constituents for Site MKG513

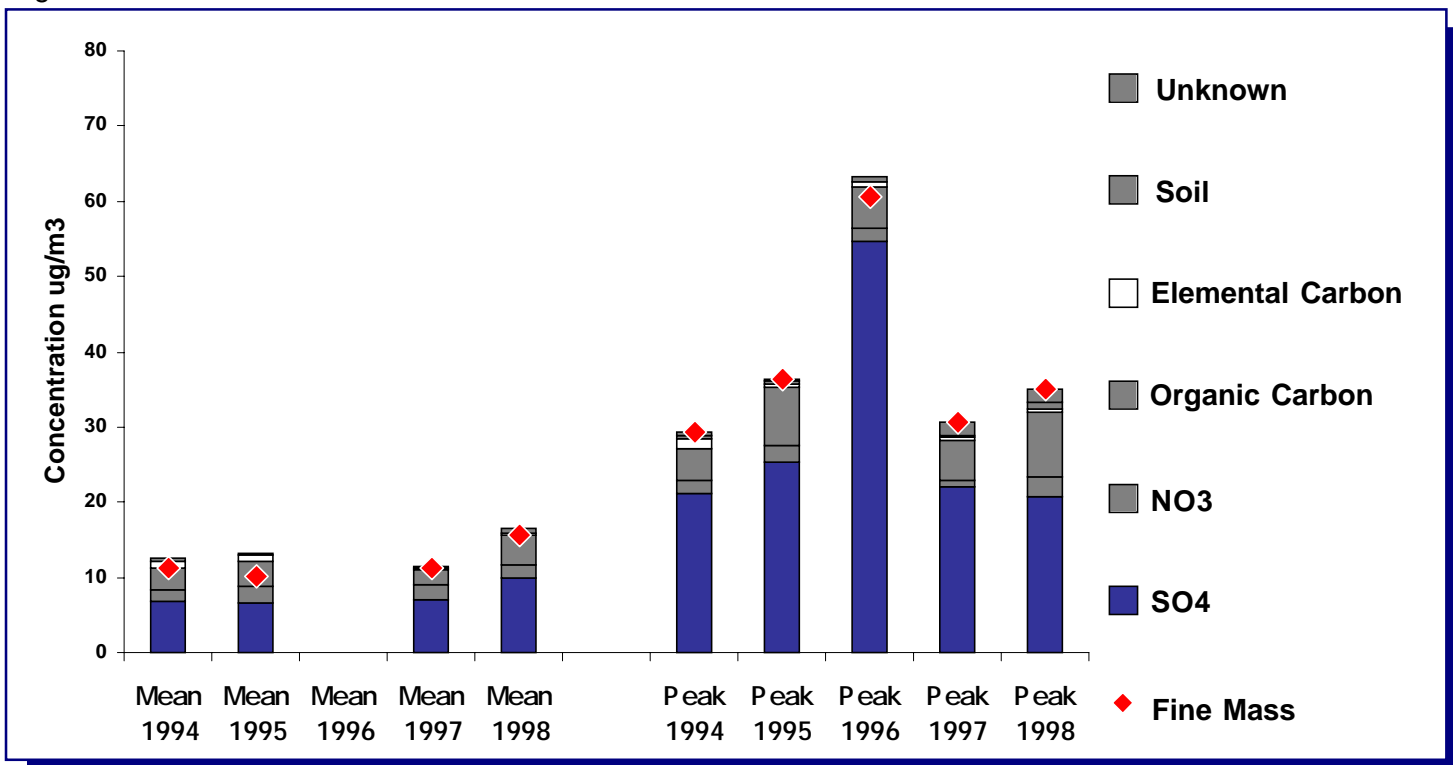


Figure 4-18. Annual and Peak 24-hour Fine Mass Concentrations and Chemical Constituents for Site QAK572

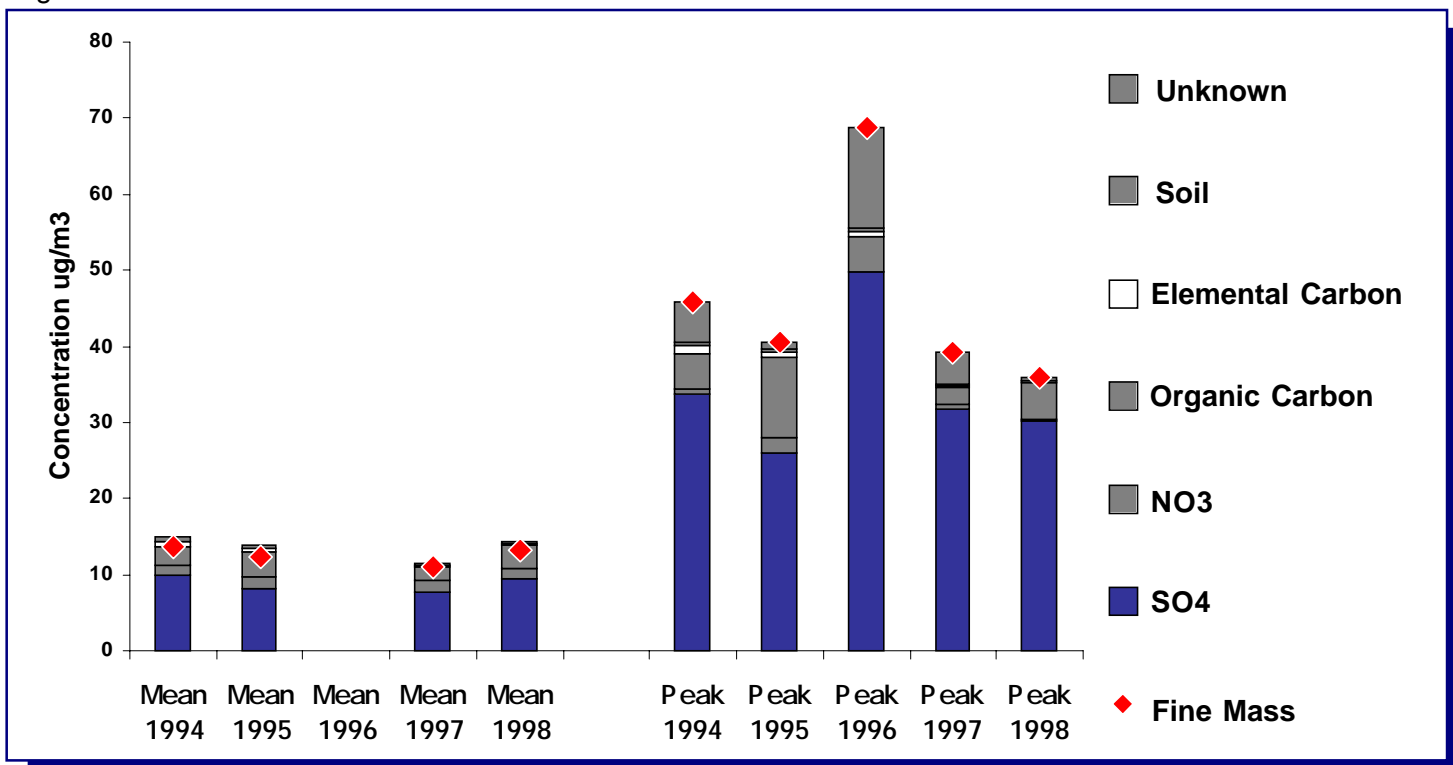


Figure 4-19. Annual and Peak 24-hour Fine Mass Concentrations and Chemical Constituents for Site LIV573

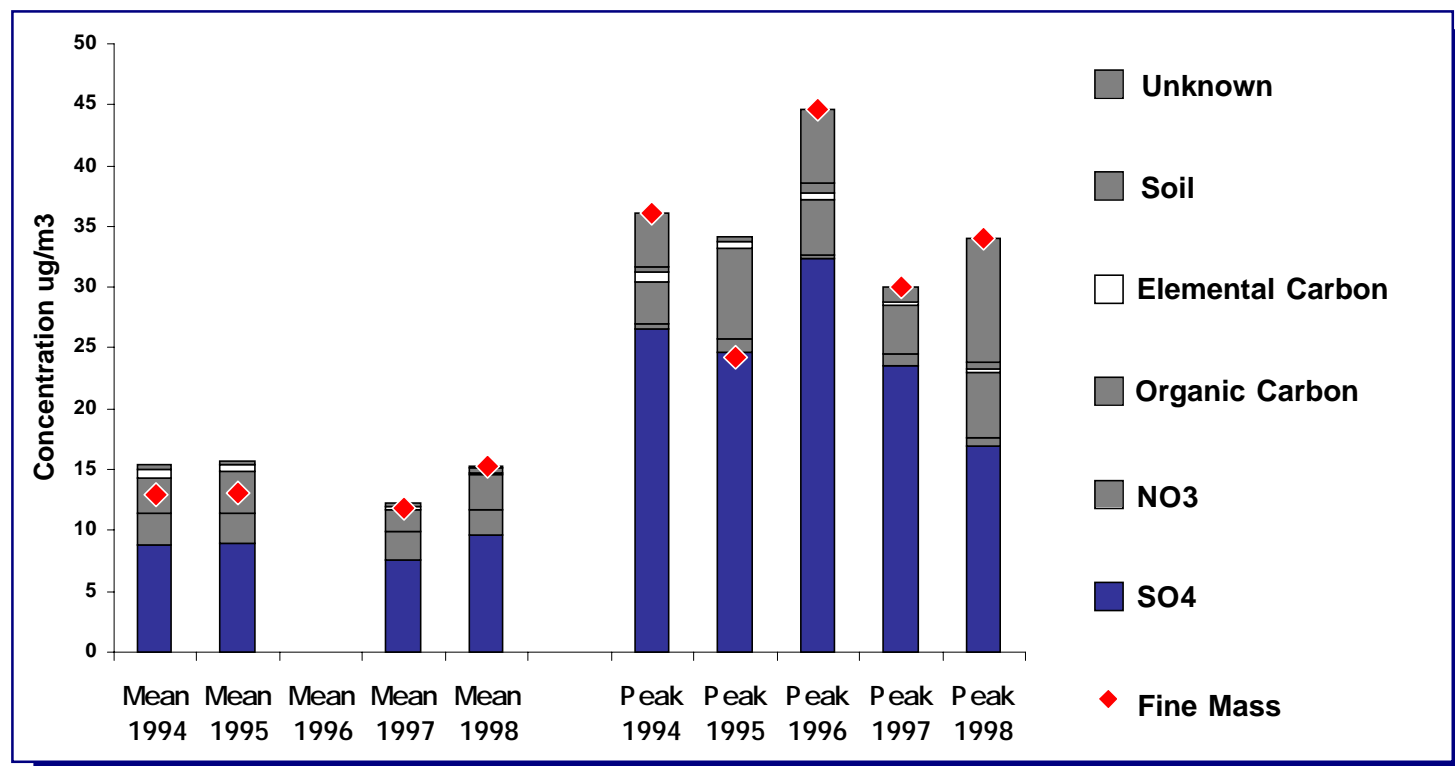


Figure 4-20. Annual and Peak 24-hour Fine Mass Concentrations and Chemical Constituents for Site BVL530

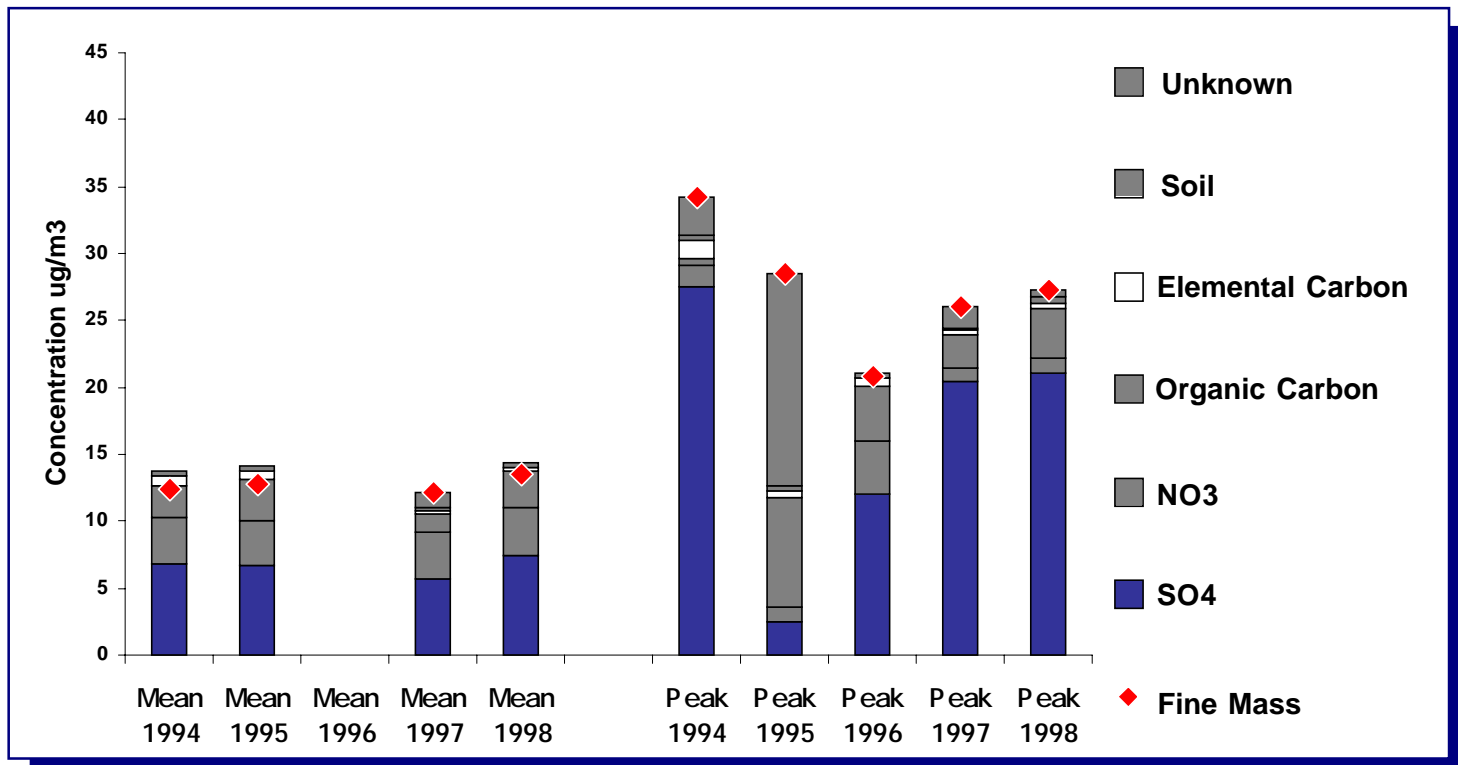


Figure 4-21. Annual and Peak 24-hour Fine Mass Concentrations and Chemical Constituents for Site CDZ571

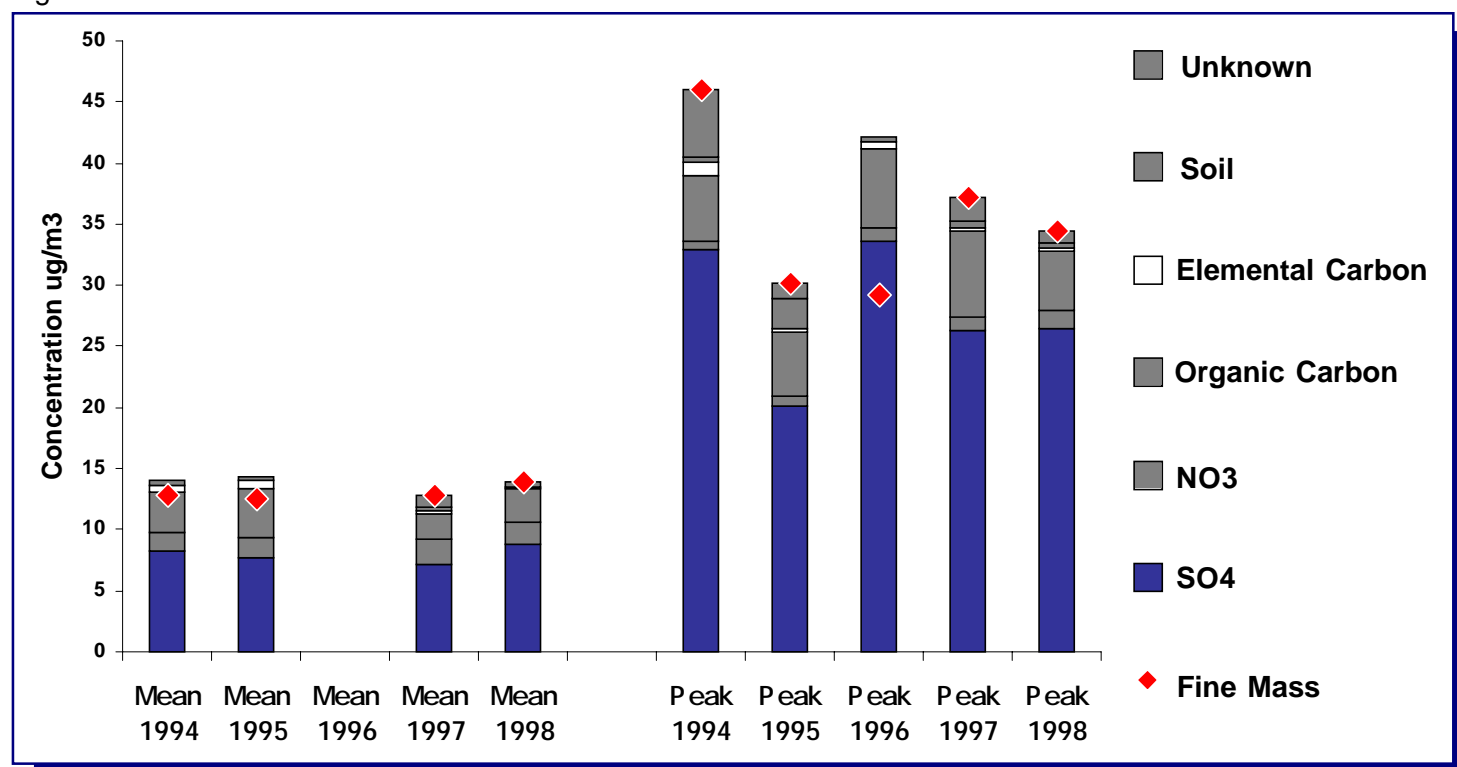


Figure 4-22. Annual and Peak 24-hour Fine Mass Concentrations and Chemical Constituents for Site SIK570

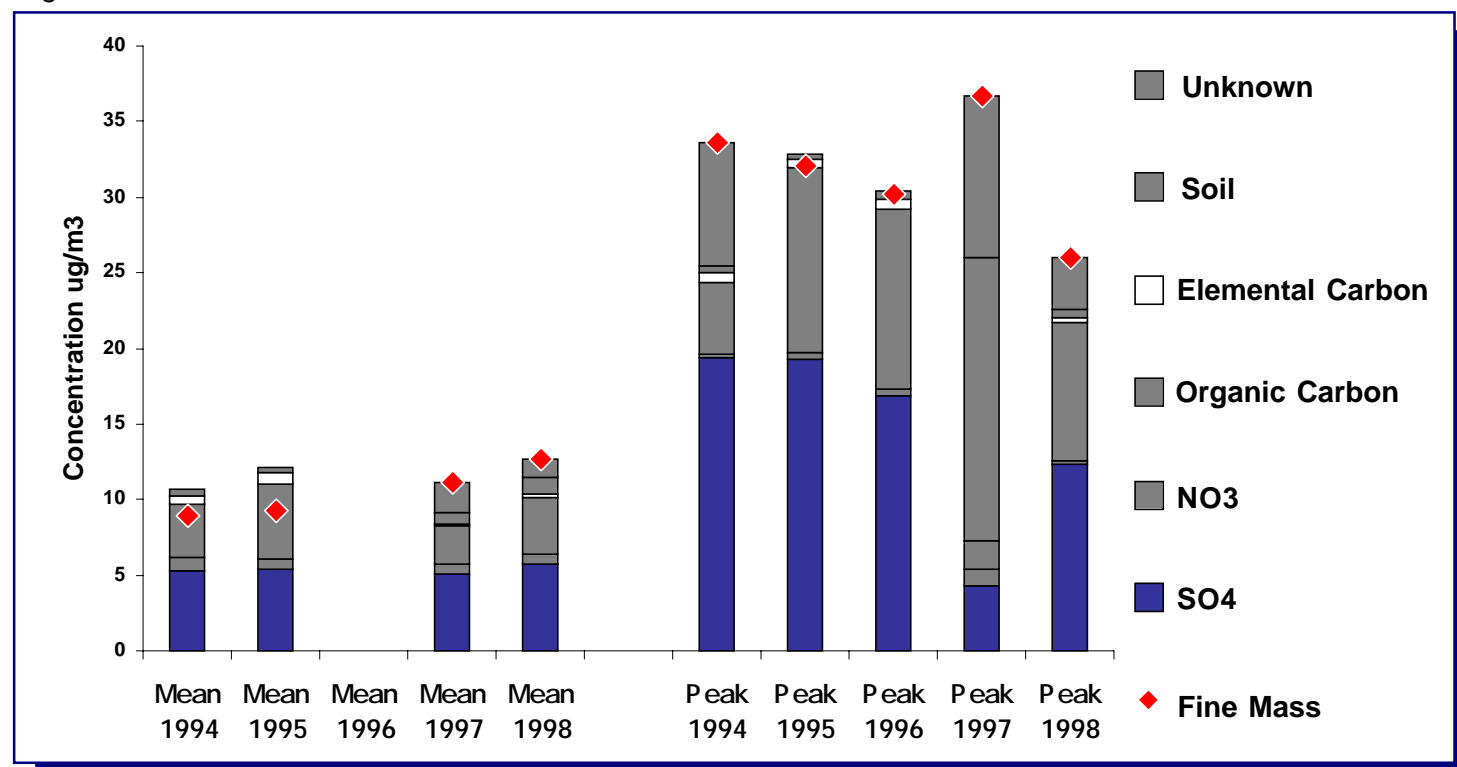
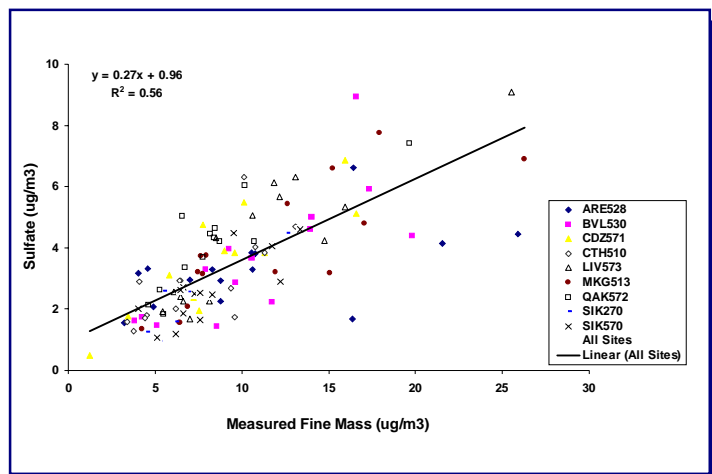
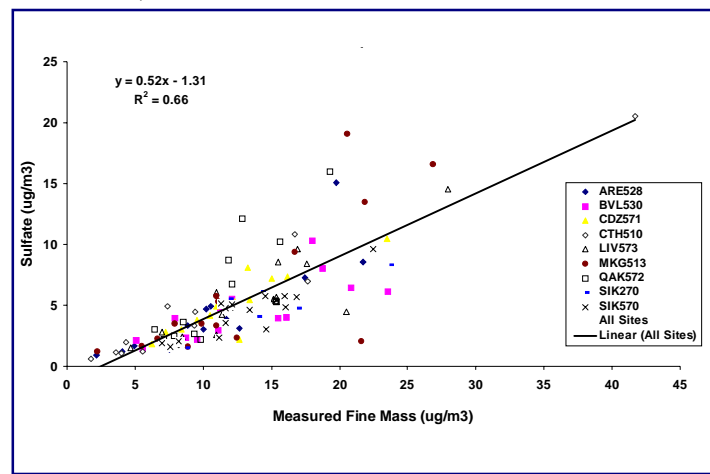


Figure 4-23. Quarterly Scattergrams of 24-hour Fine Mass and SO_4^{2-} Concentrations for all Visibility Monitoring Sites in 1998

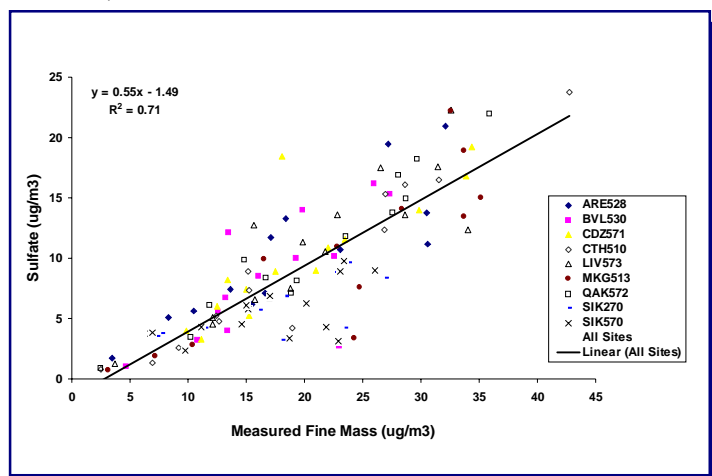
First Quarter



Second Quarter



Third Quarter



Fourth Quarter

